which is altogether new, and contributes to the strength on a totally different principle. When a frame-work has the form of a parallelogram, its power to preserve that form depends solely on the strength of the joints; but when the space surrounded by this outline is filled with the same kind of materials, then every part will sustain a proportionate share of any force applied. Accordingly, in the new system, the openings between the ribs are filled in with slips of timber nearly to the height of the orlop, or lowest tier of beams; and when these pieces have been fitted, and closely wedged together, they are caulked and pitched over, so as to make the whole frame, from head to stern, to within a few feet of the greatest draught of water, one compact water-tight mass of timber. Hence, even if any of the outer planking of the bottom were to be knocked off, the ship might not only for a time be kept afloat, but permanently be secured from sinking; whereas, upon the old system, the starting of a plank has been often fatal to the ship and crew.

In addition to these principal improvements of Mr. Seppings, others of less importance are also described, and some observations are added respecting the economy of the new construction, not only with regard to the quantity of timber necessary, but also the quality, and the facility of replacing any parts that may afterwards be found decayed.

*Remarks on the employment of Oblique Riders, and on other alterations in the construction of Ships. Being the substance of a Report presented to the Board of Admiralty; with additional demonstrations and illustrations. By* Thomas Young, *M.D. For. Sec. R.S.* Read March 24, 1814. [*Phil. Trans.* 1814, *p.* 303.]

Dr. Young observes, that the question respecting the best disposition of the timbers of a ship is by no means so easily discussed as may be supposed by those who have considered the subject but superficially; and deprecates, on the one hand, the forming a hasty determination from a few plausible experiments, as only tending to expose those who are influenced by it to very dangerous errors; and, on the other, the total rejection of the conclusions formed from such experiments without a minute examination of the objections brought against them. He enters into a detailed enumeration of all the force that can act on the fabric of a ship, and into an exact calculation of the probable magnitude of each in such circumstances as are likely to occur; and afterwards considers how far the resistances to be opposed to those forces are sufficient to withstand their action. The strains which occasion the effect of arching are, he observes, of two kinds; the one derived from the distribution of the weight of the ship, with its contents being not duly proportioned to the pressure of the water; the other, which has not hitherto been noticed, from the simple and unavoidable application of the longitudinal pressure of the water to the lower parts of the ship only, amounting to more than one third as much as the former, in the case of a seventy-four gun ship of the usual dimensions, being equivalent to the effect of a weight

of about 1000 tons, acting on a lever one foot in length, while the strain arising from the unequal distribution of the weight, and the displacement, amounts, where it is greatest, to 2600, although it is somewhat less than this exactly in the middle of the vessel. The next force investigated by the author is that of the waves, which he considers as including the consequences of the effect of the wind; and this he finds capable of becoming much greater than the former, amounting, in particular cases of the effect of a series of waves, to a strain of about 10,000 tons, and their difference more than 6000 when the waves are in a contrary direction. Hence it is inferred, that although these occasional strains exceed in magnitude the permanent causes of arching, they do not by any means make it superfluous to give the greatest strength to the fabric in the direction which is best calculated for the prevention of that effect. It is also remarked, that when fastenings have once given way to an occasional force of this kind, the ship must naturally assume the form which is determined by the operation of more permanent causes; and this circumstance may lead the inattentive observer to false conclusions respecting the manner in which the injury has been sustained. The tendency to breaking transversely arises from causes precisely similar to those which have been mentioned as operating longitudinally; but their precise magnitude does not appear to be easily calculable. The force tending to produce a lateral curvature has commonly been in some measure neglected, for want of a permanent strain in a similar direction, capable of exhibiting its effects; but Dr. Young estimates its magnitude, in certain cases of waves striking a ship obliquely, to be nearly or fully equal to that of the vertical strain, as already computed. The manner in which a ship gives way when she strikes the ground is next described; and the effects of partial moisture in promoting decay are mentioned as the last of the evils which it is the object of the builder to obviate, as far as it is in his power.

Dr. Young proceeds to consider the arrangements that are best adapted to obviate the various strains which are likely to occur in the fabric of a ship, and observes, that the principal, if not the only, advantage of oblique timbers is in the additional stiffness which they afford; since the ultimate strength, or the resistance at the point of breaking, is little, if at all, affected by them in the cases which have been proposed for experimental examples, though, in some other cases, the strength as well as the stiffness may be surprisingly increased by the obliquity of the substances employed. In a ship, the utility of oblique timbers must depend in great measure on the changes which are observable in cases of arching, whether they consist most in an alteration of the angular situation of the parts, or in the want of continuity from a failure of the fastenings. From actual observations made at Chatham, he concludes that half of the effect produced depends on one of these causes, and half on the other; and infers, that so far as a change of the angular position of the timbers is found to take place, the addition of oblique braces must be of the

greatest utility; an opinion in favour of which he adduces the authorities of Bouguer, Gobert, and Don George Juan. He then proceeds to calculate how far Mr. Seppings's braces are strong enough to sustain alone the force to which it has been proved that their situation is likely to expose them; and finds that they will support, without being crippled, such a change as may be expected when a seventy-four arches about two feet, but not more; and that they will afford a resistance fully sufficient to withstand a strain much greater than that which has been attributed to the pressure of the waves, and to the usual causes of arching. Dr. Young does not apprehend any evil from the omission of the internal planking between the parts, nor from the removal of the partial remedy which the immersion of the ends, produced by arching, affords to the unequal distribution of the weight and pressure. The filling-in between the timbers in the hold he considers as wholly unexceptionable; and remarks, that wedges may easily be driven in such a manner, while the ship is on the stocks, as to have a tendency to render the keel convex rather than concave below, and to prevent the common effect of arching when the ship is launched, without any other superiority of strength or workmanship; and that, without some such accidental cause, no ship when launched could be wholly free from a perceptible degree of arching. He doubts the superiority of Mr. Seppings's iron fastenings of the beams when acting as ties; and observes, that the obliquity of the planks of the decks diminishes in some degree the strength of the tie with respect to arching; but remarks, that it may perform a very important service in rendering the ship more capable of resisting the lateral strains, which, although sometimes very violent, have been little considered by theoretical reasoners: and he suggests that it may be possible to fix the carlings between the beams in such a manner as to contribute more materially to the strength in this respect. In case of the ship's grounding on a hard bottom, Dr. Young is disposed to think Mr. Seppings's construction somewhat weaker than the common one, on account of the omission of the ceiling; although an experiment made on the Tremendous proved that a force more gradually applied could be sustained without injury. And he concludes from the whole examination, that none of the objections which have been hitherto advanced appear to be sufficiently valid to warrant a discontinuance of the cautious and experimental introduction of Mr. Seppings's arrangements, which has been commenced by order of the Board of Admiralty.

*Some further Observations on Atmospherical Refraction. By* Stephen Groombridge, *Esq. F.R.S.* Read March 31, 1814. [*Phil. Trans.* 1814, *p.* 337.]

In the author's former communication to the Society on the subject of atmospheric refraction, he considered the observations of stars that were more than 80° from the zenith as not to be sufficiently depended upon for the determination of refraction in general; and